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EVALUATION OF OZONE INJURY ON THE STANISLAUS NATIONAL FOREST

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ABSTRACT

Forty-six ground plots containing ponderosa and/or Jeffrey pines were evaluated for possible ozone injury on the Stanislaus National Forest in 1981. Ozone symptoms were widespread on the Stanislaus: On 83 percent of the plots at least one tree out of ten had ozone symptoms. Nearly 70 percent of the plots had slight injury, 15 percent had moderate injury, and only 17 percent had no symptoms. No plots had ratings higher than moderate. Plots with moderate injury were found at lower elevations, less than 5000 feet. The Forest Pest Management Staff will continue its assessment of ozone injury in the central Sierra Nevada.

INTRODUCTION

In September and October 1981, the Forest Pest Management Staff conducted a ground survey of ozone injury to ponderosa and Jeffrey pines on the Stanislaus National Forest. The survey was designed to broadly determine the extent and intensity of ozone injury to pines on the forest.

Forty-six widely scattered plots of ponderosa and/or Jeffrey pine were selected for data collection. These plots were selected at random so there would be one plot per township on the Stanislaus National Forest. Plot sites were considered valid if ten ponderosa and/or Jeffrey pines were found within an area one chain (20 meters) by six chains (121 meters) on each side of and parallel to the road or trail. The near edge of each plot was separated from the roadside influence by one-half chain (10 meters). Within each plot various site and tree characteristics were observed or measured. Some of the important data collected included the level of ozone injury, other pests present on each of the ten trees, plot elevation, crown class, stand type, density, and live

crown ratio. Pest data was collected to avoid confusing other abiotic or biotic symptoms with ozone injury. The foliage of ten ponderosa or Jeffrey pines on each plot was examined for chlorotic mottling beginning with older needles and progressing to the current season's needles. Only ponderosa and Jeffrey pines were included, because they are the most sensitive ozone injury indicator conifers in California. Ozone symptoms were evaluated by examining branches from the lower crown of each tree. The scoring system used to determine plot score is shown in Table 1. It is based on the severity of chlorotic mottle present on pine foliage. Pines with symptoms were given a score from 0 to 4, the number indicating how many years of retained needles were healthy or free of ozone-caused mottle. Trees with no symptoms and trees with symptoms on the fifth year or older needles received a score of 4. The ten individual tree scores were averaged to yield a plot score, and the overall injury for each plot was described as listed under "Extent of Injury" in Table 1.

TABLE 1. FPM Ozone Injury Scoring System for Pines.

INDIVIDUAL TREE SCORE	YOUNGEST NEEDLES WITH SYMPTOMS	AVERAGE PLOT SCORE	EXTENT OF INJURY
0	Current Year	0 - 0.9	Very Severe
1	Second Year	1.0 - 1.9	Severe
2	Third Year	2.0 - 2.9	Moderate
3	Fourth Year	3.0 - 3.9	Slight
4	None	4.0	No Symptoms

PLOT LOCATIONS

The location of the plots and the ozone injury ratings were placed on a map of the survey area. Figure 1 was drawn from this map.

RESULTS

Table 2 shows that about 83% of the 46 sample plots exhibited slight to moderate symptoms of oxidant injury. Only 17% of the sample plots were free of oxidant - induced chlorotic mottle. No plots had ratings above Moderate, and plots with Moderate injury were found only between 3,000 and 4,900 feet. The level of injury decreased at the higher elevations and in areas further removed from the Central Valley (Figure 1).

The amount of damage being done to the ponderosa and Jeffrey pines by smog is unknown. We estimate that trees with symptoms on fourth year or older needles (Slight, Very Slight, and No Symptom ratings) are probably

not suffering appreciable growth loss, and these three categories account for about 85 percent of the sample plots. The remaining 15 percent of the sample plots had Moderate symptoms. The trees in these plots had, on the average, ozone symptoms on third-year and older needles, and had two years of unaffacted needles. Normally between 60 and 80 percent of the total photosynthetic capacity of ponderosa pines lies with the first and second-year needles. It is possible, then, that pines with ozone injury on third year and older needles (Moderate injury) may suffer some growth reduction.

Although none of the survey plots was rated to have more than Moderate injury, some points should be kept in mind. Sample plot scores are the averages for ten trees, and pines vary greatly in their sensitivity to ozone. Within some Moderate and even Slight injury-rated sample plots, there were individual trees with smog symptoms on second-year needles and with only two years of needle retention. These trees are obviously growing under stress.

Table 3 shows the distribution of ozone injury scores of individual trees in the sampling plots. Some 30 percent of the trees examined showed foliar ozone symptoms, while less than 1% had symptoms on current year's needles.

ASSOCIATED INSECTS AND DISEASES

The insects most frequently observed in the surveyed pines were aphids (Cinara spp.) and the pine needle scale (Chionaspis pinifoliae). Dwarf mistletoe (Arceuthobium campylopodum) and Elytroderma disease (Elytroderma deformans) were the most commonly-encountered tree diseases.

This survey was not designed to determine if there are any relationships between insects or diseases and ozone injury, but we are aware that such situations may exist.

DISCUSSION

The 83 percent of plots exhibiting symptoms of oxidant injury on the Stanislaus is slightly higher then the 79 percent combined results of injury trend plots evaluated on the Sierra and Sequoia National Forests in 1979/80[1]. Seventeen percent of the plots on the Stanislaus had no symptoms compared to 21 percent in the southern Sierra Nevada. Fifteen percent of the plots on the Stanislaus had moderate injury, while those on the southern Sierra Nevada had 17 percent. In the southern Sierra Nevada, plots with moderate injury were found at all elevations except 8000 feet. These differ considerably from the Stanislaus where all plots with moderate injury were found at elevations less than 5000 feet.

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[1] Pronos, J., and D. R. Vogler. 1981. Assessment of Ozone Injury to Pines in the Southern Sierra Nevada. U.S.D.A. Forest Service, Region 5, Forest Pest Management Report 81-20. 13 p.

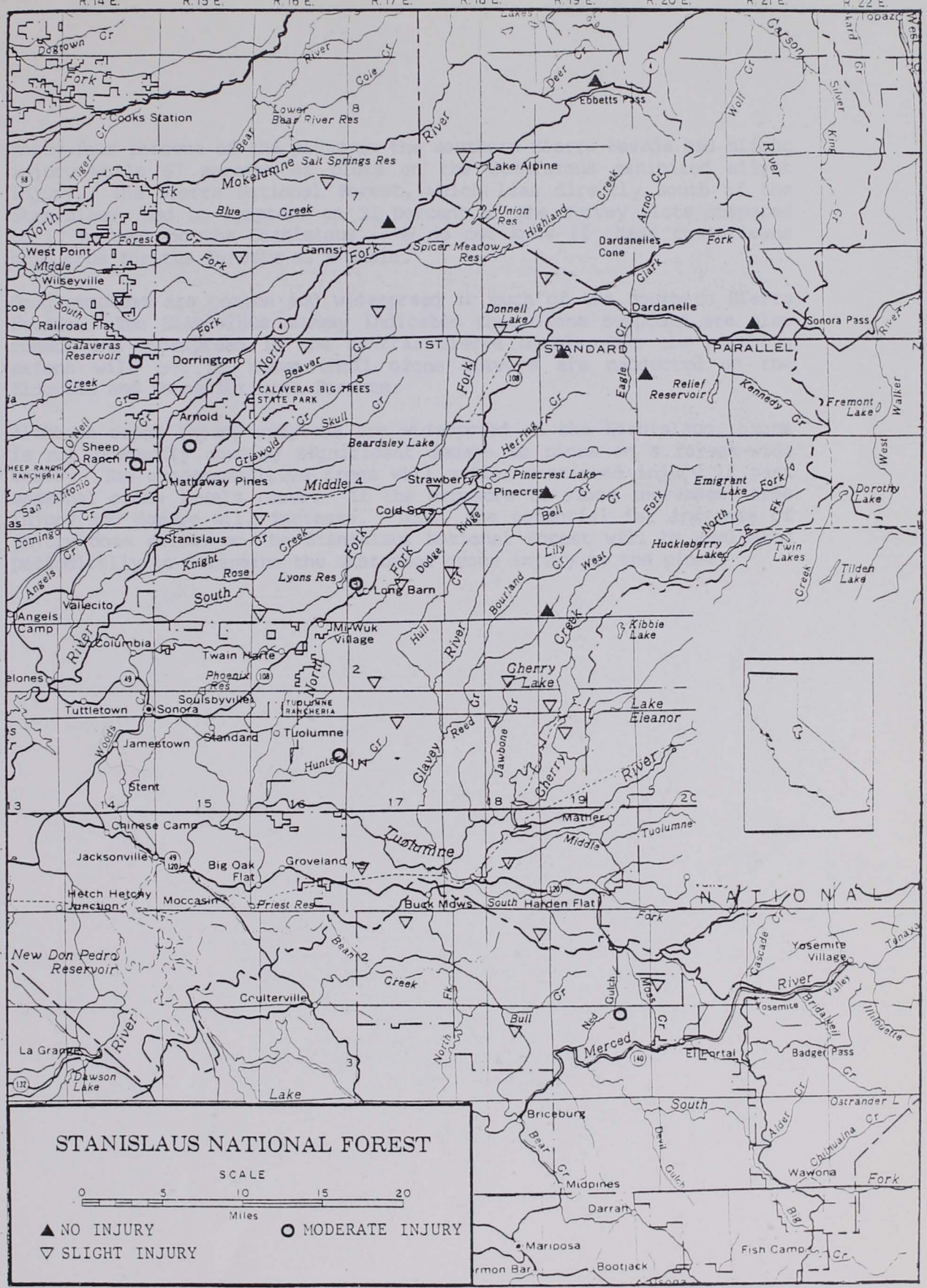

Figure 1. LOCATIONS AND INJURY RATING OF OZONE INJURY SURVEY PLOTS ON THE STANISLAUS NATIONAL FOREST, 1981.

Forty-four percent of the plots on the southern Sierra Nevada had slight injury while 67 percent of plots on the Stanislaus exhibited slight injury. The Sierra National Forest, which lies directly south of the Stanislaus, had no symptoms on 21 percent of the survey plots compared to 17 percent on the Stanislaus. We do not know if these comparisons hold true for the Forests as a whole.

Smog symptoms are common and widespread in much of the southern Sierra Nevada. The Stanislaus survey indicates that ozone symptoms are also common and widespread in the central Sierra Nevada, but the northern extent will not be known until ozone surveys are conducted on the Eldorado and Tahoe National Forests.

Although ozone injury symptoms are widespread on the Stanislaus, ozone is not presently causing significant damage to pines on a forest-wide basis. The ozone-sensitive trees will suffer continued injury if past seasonal ozone levels recur. If the exposure to ozone increases, tree injury and damage will increase. Thus, the potential for increase of injury does exist, so the Stanislaus National Forest will be evaluated periodically to determine the status of ozone injury to the pines.

TABLE 2

PLOT RATING FOR OZONE INJURY ON THE STANISLAUS NATIONAL FOREST, 1981

ELEVATION (Feet)	NUMBER OF SAMPLING PLOTS BY OZONE INJURY RATING			
	MODERATE (2.0-2.9)	SLIGHT (3.0-3.9)	NO SYMPTOMS (4.0)	TOTAL
2000-2900		1		1
3000-3900	4	8		12
4000-4900	3	6		9
5000-5900		8		8
6000-6900		6	3	9
7000-7900		2	3	5
8000-8900			2	2
TOTAL	7	31	8	46
(Percent)	(15.2)	(67.4)	(17.4)	(100)

TABLE 3

THE PERCENTAGE OF INDIVIDUAL PONDEROSA AND JEFFRY PINES

BY OZONE INJURY RATING, STANISLAUS NATIONAL FOREST, 1981
(Total Trees - 460)

TREE RATING	PERCENT TREES
No Symptoms (4)	70.4
Slight (3)	6.5
Moderate (2)	15.7
Severe (1)	6.4
Very Severe (0)	0.4